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Can Australia transition to an agroecological future?

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ABSTRACT

Australia faces seemingly impossible barriers to transitioning to agroecology. Nonetheless, many possibilities for a distinctively Australian agroecology exist. Some Australian farmers have helped create methods for rehydrating landscapes, while Indigenous peoples are reclaiming crops and farming methods well-adapted to Australia's diverse regions.To appraise the prospects for agroecological changes in Australia, I modify in two ways the Multi-Level Perspective framework widely used in transitions research. First, I elaborate the notion of lock-ins that impede systemic change. Looking at Australia reveals an array of socio-ecological lock-ins that matter alongside the more familiar political economy lock-ins. These include settler colonialism, climate/environmental change, and scientific & technological priorities. Second, I add 'massification' (or the growth of a movement supporting change toward agroecology) as one possible process for overcoming these lock-ins. I work through several key drivers of the process of taking agroecology to scale to show how agroecological transition might happen.

KEYWORDS

Agroecology; Australia; MLP framework; lock-ins; massification

Introduction

Australia faces seemingly impossible barriers to transitioning to agroecology. Since the 1980s, Australian agricultural policy has taken a strong neoliberal stance. Farmers are exposed to global markets with little government assistance. Like other industrial countries, corporate power has intensified through domestic market oligopolies. Supermarkets and food processors have pursued low-cost strategies, further squashing many farmers. Instead of a national food policy, the country has an agricultural competitiveness policy that devotes superficial attention to environmental concerns. Atop long-running environmental declines in biodiversity, soils, and forests that make it harder to farm, climate change is amplifying the effects of drought and bushfire. Policy-maker, industry, and scientist elites believe in technological solutions to sustain growing production.

Nonetheless, many possibilities for a distinctively Australian agroecology do exist. Some Australian farmers have helped create methods for rehydrating landscapes, while indigenous peoples are resurrecting crops and farming methods

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well-adapted to Australia's diverse regions. Climate change is starting to evoke conversations among farmers about alternative agricultures. Therefore, examining how agroecology might take hold in Australia can provide insights into processes of transition for inspiration elsewhere. If the difficult situation in Australia can change, then other countries with similar challenges could as well.

Agroecology initially emphasized the application of ecological knowledge to managing low-input, diversified farms: making healthy soils, recycling nutrients, using water and energy effectively, and enabling beneficial interactions of organisms with farm ecosystems (e.g. Altieri 1995; Gliessman 2014). Agroecological practices include intercropping, crop rotations, mixed crop/livestock systems, composting, use of plants, insects, and birds to regulate pests, and elimination of agrochemicals. Many agroecologists now view agroecology as a combination of science, practice, and movement (Wezel et al. 2009; Mendez et al. 2013). Alongside diverse sciences from ecology to soil science, much agroecological practice comes from "the local, empirical, and indigenous knowledge of farmers and the sharing of this knowledge" (Gliessman 2018). Hence many agroecologies exist in practice worldwide because of diverse local perspectives (Mendez etal. 2013). As Gliessman (2018, p.600) explains, agroecology is also "action-oriented because it confronts the economic and political power structures of the current industrial food system with alternative social structures and policy action". For industrial countries such as Australia, IPES-Food (2016) notes that agroecology systems have not yet been used at scales large enough to reveal their full potential, and have not benefited from substantial investments and an enabling policy environment.

To appraise prospects for agroecological changes in Australia, I apply the Multi-Level Perspective framework widely used in transitions research, and modify it in two ways. First, I elaborate the notion of lock-ins that impede systemic change. Political, technological, and infrastructure lock-ins are well-known in the transitions literature – as seen in the growing work around 'carbon lock-in' (Unruh 2000). Such lock-ins are putting Australia on a trajectory similar to what Turner et al. (2018) modeled for the future. Without major changes, Australia will continue to rely on intensive, technology-using, export-focused agriculture.But looking at Australia reveals an array of *socio-ecological* lock-ins that matter enormously too. For example, settler colonialism has reshaped landscapes and ecologies massively – and made indigenous agriculture invisible. Second, I add 'massification' (or the growth of a movement supporting agroecological change) as one possible process for overcoming these lock-ins. Facing a strongly entrenched industrial agriculture regime, massification could provide the impetus that has been missing from Australia in transitioning to a different pathway.

To begin, I briefly sketch Multi-Level Perspective theory. Then, in the first half, I survey a mix of political economy and socio-ecological lock-ins that make it difficult for agroecology to spread in Australia. In the second half,

I work through potential drivers of massification in the Australian context and identify key openings for change.

Transition, lock-outs, and massification

A large body of social science research worldwide has explored many dimensions of agroecology, including the politics of making agroecological knowledge, farmer-to-farmer learning, the role of social movements, and numerous cases of national and sub-national initiatives. Nonetheless, relatively few analysts have applied transitions scholarship to agroecology, particularly the Multi-Level Perspective (MLP) framework. Anderson et al. (2019) have begun exploring how self-organization and bottom-up governance can enrich MLP analysis, while Ingram (2018) has considered how permaculture knowledge systems develop locally and interact with the dominant agrarian regime. Vanloqueren and Baret (2009) thoroughly analyze how university and public research systems have progressively locked out agroecology in favor of biotechnology pathways.

First developed by Dutch sociologist Frank Geels (2002), the MLP framework follows the growth of a transition through many processes interacting simultaneously with one another at niche, regime, and landscape scales. A transition happens when these processes "link up and reinforce each other" (Geels 2005, 453). The landscape comprises deep, slowly maturing structural influences, such as demographic changes, economic growth, and political culture. These features are difficult to alter through human interventions. A regime is the dominant technological or production system, like industrial agriculture, which has its own enduring rules, practices, and material infrastructure. Niches are where alternative idea ssuch as agroecology can begin maturing, because they are protected from – and do not threaten – the regime's powerful economic and political forces. They may be local experiments, R&D programs, start-ups, or market segments. Geels (2005) says: "Because the performance of radical innovations is initially low, they cannot immediately compete on mainstream markets in the regime" (p. 450). Niches allow social learning to take place, support networks to coalesce, and different norms to develop. These elements can aid the idea to survive and compete better within the regime.

Geels (2002) proposes that transitions start from niches and can break out if regime and landscape changes provide an opening. For example, powerful actors might "use their financial, organizational or political capital to stimulate its development and help overcome resistance from other social groups" (Geels 2005, 451). The regime might be destabilized by internal challenges (e.g. demand for sustainable food) that it cannot resolve, and by landscape changes (such as climate change) that generate growing friction. Such openings may lead to niche experiments proliferating and remaking the regime step-by-step. For example, agroecology practices and farmer schools can expand from the

margins into the existing agrarian education/extension system. Niche developments may also 'ride along' with regime changes, such as new markets or corporate policies that favor agroecology. Niches grow in their sizes, market shares expand, and new infrastructure, networks, cultural enthusiasm, and user skills emerge – enabling agroecology to successfully compete with, and eventually displace, industrial agriculture. But I would add, some powerful actors within regimes can catalyze (or accelerate) transitions, as with governments deciding to enact a nationwide agroecology law that requires farms to adopt diversified cropping. Radical innovation is not confined to niches; it can take place inside parts of the regime. Both directional pushes may co-exist in a given situation.

However, MLP theory needs to develop further the role of 'lock-ins', or technological, institutional, economic, and political constraints on the ability of existing systems to change (Seto et al. 2016; Unruh 2000). Regimes contain these constraints because of how they have evolved over time; landscape conditions may also contribute to lock-ins. The key consequence of lock-ins is that they create path dependencies favoring perpetuation of the regime. Once a regime becomes stabilized, it tends to accrete co-evolved, enduring infrastructure, institutions, and behaviors within which actors must operate or live. Lock-ins are process-based: they function through positive or negative feedback loops that cascade across the regime. Anderson et al. (2019) use 'disabling dynamics' to describe how these loops inhibit the emergence of alternatives. But lock-ins can be disrupted or diminished. Some transitions analysts (e.g. Delina 2016) think that only external (landscape-scale) developments, like climate crises, can disrupt regime-scale lock-ins. In contrast, Unruh (2002) argues that climate policies purposefully investing resources in niche innovations can help these to become technologically superior to existing energy systems. Moreover, widely shared public consensus on the need for a transition could undermine institutional lock-ins. Unruh suggests: "the escape from carbon lock-in should not be seen as the result of a single change, but rather a series of complex, interconnected changes in multiple variables" (p.321).

In terms of industrial agriculture, the IPES-Food group has identified eight key lock-in cycles that must be weakened for alternative pathways to succeed (IPES-Food 2016). For example, "a web of interlocking market and political incentives tailored to large-scale farming" (p. 46) reinforces the use of industrial methods. Research and extension, government subsidies, and retailer bulk supply preferences favor industrial farmers. Farmers must invest in acquiring skills, equipment, networks, and retail relationships associated with industrial agriculture, and could lose these if they converted to agroecology. Farmers, in short, would risk their livelihoods in trying to escape the productivist system. All these barriers or factors combine to create a lock-in. Other lock-ins include concentration of industry power, export orientation, the expectation of cheap food, 'feed the world' narratives, and measures of success.

All these lock-ins matter greatly in Australia. Yet IPES-Food focuses on the political economy forces, technical models, and government and corporate policies that entrench industrial agriculture. Australia shows the importance of *also* integrating socio-ecological lock-ins to understand (1) what was possible in the past and (2) what is being envisaged for the future. Namely, histories, ecologies, land use regimes, cultural beliefs, philosophies of government, and scientific and technological visions can converge to make alternative agricultures seem impossible, anachronistic, or impractical. For example, settler colonialism created a particular agrarian trajectory in Australia, eradicated agroecosystem potentials through massive land clearing, and erased indigenous farming systems that could have inspired alternative agricultures. Geographical and environmental conditions have made – and are making – it hard for farmers to adopt agroecological practices. Strong beliefs among scientist, industry, and government elites in the power of science and technology to overcome climate constraints are leading to agroecology being ignored. Table 1 summarizes these lock-ins.

Table 1. Summary of key socio-ecological and political-economic lock-ins that shape agroecological prospects in Australia.

Lock-in	Effects and loops	Implications for agroecology
European agricultural model	Ongoing challenges of adapting to dynamic climate; land/soil damage; destruction of biodiversity; production heavily based on less suitable crops and animals; dependence on irrigation and 'cash crops'.	Loss of ecological, water, and soil resources that could be used for agroecology; deep investment in less suitable crops and animals; neglect of dry farming methods; ideas about what a farm should look like.
Settler colonialism	Erasure of Indigenous agricultural knowledge and practices; 'war' on nature; frontier exploitation attitudes.	Loss of diverse animals and crops that could be used across continent; deep resistance to ecological farming.
Geography	Diverse agricultural/land zones; mostly semi-arid continent; lower soil fertility in parts; extremely dynamic climate.	Need to adapt to different conditions; need to rehydrate landscape; need to rebuild soil health.
Policy-making institutions	Capture of government decision-making by industry interests and economists; farmer lobby predisposed to productivism; major parties committed to extraction.	Policy preferences for industrial agriculture; emphasis on bigger farms; revived interest in large-scale pipeline and Northern Australia plans.
Neoliberal agricultural policies	Evisceration of historical rural welfare system; lack of farmer support; growing farmer and rural poverty; emphasis on exports and competitiveness; absence of national food policy.	Weak farmer resources for adopting agroecological practices; demoralized and eroding rural communities; investment in export support instead of environmental support; no mechanism for national agri-food.
Industry supply chains	Growing industry consolidation; dominance of supermarket chains; emphasis on low cost food.	Lack of markets for agroecological or sustainable foods; lack of farmer power vis-à-vis food industry; artificially low cost of food.
Environmental/climate developments	Accelerating climate impacts; lengthy droughts (2 in past 20 years); bushfires; water scarcity.	Likely heat, water, and extreme event constraints on much of continent that agroecologists may not adapt to.
Science & technological visions	Long-running scientific agricultural paradigm; emerging interest in robotics, big data, gene editing, glasshouse production.	Lack of investment in agroecological and regenerative methods; narrow conception of technology and neglect of appropriate-scale technology.

Part of the landscape scale, these features have shaped the ways in which the industrial agriculture regime has evolved over many decades. Some features (e.g. neoliberal government and land use regimes) are common to other industrialized countries. Others are unique to the Australian context (e.g. particular ecologies and indigenous knowledge systems). If we look critically at these socio-ecological lock-ins, we can see that many innovations are 'locked *out*' because of how a country has developed, for example. It is not that innovations cannot compete with the dominant system due to inadequate performance. Rather, innovations are locked out due to site-specific conditions that make it challenging for farmers to adopt them, or for policy-makers to seriously consider them. Even innovations that are mature in terms of practice, knowledge, and networks in places elsewhere, can founder under these circumstances.

Finally, MLP theory does not clearly explain how niche innovations might change regimes. Geels and other scholars suggest that niches gradually accumulate and lead to wider use and improved ability to compete. But this neglects 'scaling' processes such as the growth of *movements* of people using an innovation – and it also overlooks the ways in which innovations can spread spatially and socially.

Here, agroecologists Mier Y Teran Cacho et al. (2018) argue that transitions can happen through 'massification' – or "a process that leads ever-greater numbers of families to practice agroecology over ever-larger territories and which engages more people in the processing, distribution, and consumption of agroecologically produced food" (p. 639). Using five case studies of in-progress massifications, they identify eight drivers that can propel transitions toward agroecology. These drivers include crises, coalescing social organization, effective agroecological practices, external allies, and favorable policies. In Anderson et al. (2019)'s words, these are 'enabling dynamics'. Scaling can take place horizontally (through spreading between people) and vertically (through spreading institutionally). Mier Y Teran Cacho et al. (2018) say that "successful scaling processes are grounded in broad-based, inclusive social movements". Without overstating their potential, movements may generate enough energy, embodied knowledge, and political power to put real pressure on entrenched regimes to start unwinding. Through cognitive and cultural change making it possible to imagine and act on fresh possibilities, massification could overcome the political economy lock-ins and socio-ecological lock-ins that the next several sections work through.

Settler colonialism, indigenous agriculture, and environment

The enduring legacies of colonial history include the imposition of a European-style agriculture onto a continent with a vastly different environment; the erasure of preexisting Aboriginal agriculture practices; enduring faith in the wealth of wool, wheat, and beef; and hostility toward indigenous ecosystems. All these elements have created a series of ongoing feedback loops that configure what

farmers can do with their land, how governments and farmers understand the nature of agriculture, and whether or not agroecology can be practiced effectively.

When the earliest British settlers arrived, beginning in 1788, they assumed that European agricultural methods could be transferred to their new land (Griffiths 1997). The same crops and animals would thrive irrespective of context. But climate scientist Joelle Gergis (2018) shows that settlers in Sydney contended with wildly fluctuating weather conditions that endangered their survival. In summer, for example, they might face fierce heatwaves lasting for weeks and then floods before yet more heatwaves. The settlers did not know that Australia is uniquely situated in the middle of four continental scale climate cycles that tug and pull on weather patterns. These include the El Nino-La Nina, Southern Oscillation, and Indian Ocean Dipole cycles. Every few years, therefore, dramatic changes in rainfall make it difficult for farmers to maintain reliable, stable production. When certain phases in these climate cycles synchronize, lengthy droughts can materialize, such as the Federation Drought in the 1890s and the Millennium Drought in the 2000s (van Dijk et al. 2013). Such droughts can shatter rural economies and make recovery challenging in subsequent decades.

Much of Australia is also semi-arid or arid land, especially in the interior. Only 6% of land is arable. In the 1880s, a colonial administrator, Goyder, surveyed lands across South Australia and discovered that these could be divided along an arc that marked a dramatic change in agrarian potential (Gergis 2018). Goyder's Line demarcates between land that can grow wheat and land that cannot support agriculture due to insufficient rain. Numerous optimistic efforts to farm north of this line have foundered over the decades (Meinig 1961; Muir 2014). Similar lines can be identified in New South Wales, Queensland, and Western Australia, such that farmers are more likely to struggle further inland on marginal lands. Existing horticultural areas inland are made possible only by irrigation from groundwater or nearby rivers, which are vulnerable to the continental climate cycles. Most grain, vegetable, fruit, and nut crops are now grown in temperate and Mediterranean zones along the coasts in eastern Australia and southwest Western Australia, as well as in Tasmania. These zones can be highly productive because of their rainfall and fertility.

In contrast, Aboriginal peoples were farming all over the country in diverse geographical regions, perhaps for many millennia. They showed that farmers can adjust to Australian environments by knowing how ecosystems work. They had developed a variety of techniques and crops that were adapted to each region, from the fecund plains in Victoria to the seemingly harsh deserts of Central Australia. Pascoe (2018) uses early settler and explorer observations as evidence of Aboriginal farming. This farming did not look like European agriculture because the Aboriginals did not necessarily plant crops or plow fields as such: they created and maintained the conditions for food plants to

flourish. For example, the murnong – a native tuber – grew in grasslands and could be harvested, processed, and stored for use throughout the year. The Aboriginals also had livestock but in a different form. They used fire as a technology to nourish grasses for kangaroos, emus, wallabies, and other food animals; and to manipulate their movements for hunting purposes (Gammage 2011). 'Wild' animals were not equated by the settlers to cattle and sheep. Moreover, in contrast to the individualistic nature of much European agriculture, Aboriginal farming was communal in character.

Yet this indigenous agricultural knowledge was systematically dismissed (Mayes 2018). To legally settle Australia, colonial authorities needed to portray the country as empty of civilized inhabitants. If the Aboriginals had been recognized as farmers, not nomads, this would have undermined the whole basis of claiming sovereignty over a vast continent. Pascoe (2018) shows that many settlers did know about Aboriginal practices but worked to erase indigenous knowledge and presence. For example, Aboriginal stone structures for housing, cooking, and fish farming were demolished as settlers began appropriating the grasslands that the Aboriginals had cultivated. The stone was even reused in farm fences.

Colonial history also marks Australian agriculture through creating ecological violence and heavy dependence on pasture. Early agriculture mostly focused on grazing cattle and sheep for meat and wool exports back to Europe, because this form was more readily introduced in the prevailing environmental conditions (Griffiths 1997). A distinctive form of grazing – 'squatting' – characterized much of the expanding settlement frontier. Settlers would move into new territories and squat without legal recognition at first. Later, colonial authorities sought to encourage more immigrants and higher rural populations through land release schemes. Pastoralists discovered that more land area per animal was required to feed livestock, particularly in drier inland areas with poorer soils. Many farmers sought to maximize short-term returns, not knowing when the next drought might arrive. In the 1880s, the sheep population in NSW grew to 13 million before starving in the Federation Drought, which lasted for almost 10 years (Muir 2014). Countless boom and bust cycles have happened in the grazing industry because of this long-persisting extractive philosophy.

Colonial livestock were as much settling forces as humans: their hooves ruined creek beds and compacted soils; they quickly ate out the grasses and food plants that Aboriginal peoples had cultivated (Rolls 1969). Within years of first cropping or grazing, settlers commonly found their yields plummeting, as Aboriginal peoples no longer managed ecosystems. Soils became harder and more impervious to water. Muir (2014) writes, "There is a dimension of 'war' about the way settler Australians have approached their land – understanding it as 'mongrel country', rather than a functioning ecosystem poorly adapted to the expectations of Western agriculture … The same society that executed

massacres caused ecological degradation on the nineteenth-century grasslands" (p.184). Thus, settlers engaged in widespread clearing of their lands. Ringbarking (or killing trees by cutting into their vascular systems) came to be identified with farming. Burning forests and scrub took place deep into the 20th century as farmers cleared more and more of their land. The quintessential Australian farm is now either cropland that is regularly fallowed and then abandoned during drought times (in the theory that planting should only happen after rain), or dusty meadows of straggling grasses and a very few trees under which sheep or cattle congregate. Far from being 'normal', this land holds the history of its colonial destruction.

Agriculture now uses roughly 52% of the continent's land, most of it for pasture (Climate Council 2015). Apart from chickens and pigs, livestock has not (yet) followed the path of the United States: most cattle come from grass-fed pasture and feedlots comprise a small fraction of production. Horticulture and dairy have been more recent, 20th century developments in response to growing urban populations. Still, beef, wool, wheat, and dairy remain by far the largest categories of food exports. This reflects a strong historical path dependence in Australian agriculture, even though these crops and animals are not as suited to diverse, harsh, varying environmental conditions as Indigenous varieties may have been.

Water has emerged as a major preoccupation in contemporary agriculture. Most farming occurs in the vast Murray-Darling Basin region that stretches from Victoria into Queensland and contains the Great Arterial Bore along with several major rivers. Irrigation has led to farmers and industries expecting that certain crops and animals – like nuts, fruits, rice, and cotton – can be produced, even in landscapes where these would not ordinarily prosper. Cotton exemplifies this situation. Wealthy farmers have captured huge amounts of water in their own reservoirs, depriving downstream farmers, communities, and ecosystems of essential water (Davies 2019a). Growers have sometimes stolen public water; poor state monitoring has occurred in other cases Hannam, 2018. Governments regard cotton as a key export crop (worth 960 AUSmillion in 2015) that justifies a permissive stance on water use. In truth, cotton yields a relatively small economic benefit compared to its actual environmental costs (only 669 AUS benefit per megaliter of water, compared to 4353 AUS for fruits and nuts, and to 8362 AUS for vegetables: Adams 2017). Since the 1990s, governments have created markets for water rights in an attempt to make water use more rational and to allow some rights to be set aside for ecological purposes. In practice, water rights have become more decoupled from their land uses, with some farmers and corporate landowners treating them as more valuable than any resulting agriculture (Mercer, Christesen, and Buxton 2007). Many towns dependent on river sources are now forced to import water. These developments mean less water for

diversified crops, weaker rural communities, and emphasis on irrigation technologies instead of working with land to retain water.

The environmental changes wrought by agricultural activity continue to happen. Many farmers still take an extractive, war-like stance to their land. Land clearing continues at a high rate, particularly in Queensland and NSW, which both have sizable woodland, scrubland, and rainforest areas left (Davies et al. 2019b). Between 2013 and 2018, 1.6 million hectares of land were cut in Queensland, largely for cattle ranching (Cox 2019). In NSW, much conversion is being driven by hopes of planting crops where they have foundered before. This activity may be a response to repeated attempts by state governments to regulate land clearing: farmers feel they must preempt these new laws. Such deforestation is partly why Australia is failing to meet its climate change treaty commitments. Though not widely understood by urban dwellers, Australia has a grave biodiversity situation (Hrdina and Romportl 2017). Numerous endemic mammals and birds are imperiled, with accelerating climate change effects compounding habitat loss. Exploitative attitudes to ecology continue to pervade land use, making it harder for farmers, policy-makers, and industry figures to accept that ecological principles could guide agriculture.

Government policies, industry consolidation, and farmer poverty

Such foundational socio-ecological lock-ins combine with political economy and institutional lock-ins that have developed more recently. The latter include a dramatic transition of government policies toward neoliberal deregulation within an overall arc of productivist development, alongside growing corporate power and worsening farmer livelihoods. These changes have defined the dominant regime for agriculture. They have helped create ongoing feedback loops that shape the kinds of policies that governments believe they can make, prioritize industrial agriculture methods, and marginalize alternative perspectives.

From the 19th into the 20th centuries, agriculture was viewed as core to the country's economy. Governments willingly intervened in the agricultural sector to meet goals that shifted over time from encouraging colonization to promoting economic growth. Because of how the Australian constitution distributed legislative powers, state governments oversaw agricultural policy, while the federal government exercised control over trade and set broad economic directions. After federation in 1901, state governments revived rural settlement initially through land release schemes and then by creating agricultural science extension systems to stimulate greater use of fertilizer and machines (Muir 2014). Following both World Wars, state governments also set aside land for returning soldiers, notably along the Murray River in Victoria and in the Goohi area of New South Wales (Baker 2018). A distinctive feature of Australian politics is the long-running existence of

a rural party, the National Party (formerly the Country Party). Since the 1920s, this party has controlled the agricultural and water ministries whenever the conservative parties have won elections.

Governments invested in supply management schemes to support farmers as part of a welfare bargain. These schemes included guaranteed pricing, two-price systems, direct subsidies, occasional production quotas, concessional loans, and marketing cooperatives (Argent 2002; Botterill 2016). For wheat, the federal government imposed a statutory marketing board that evolved into the Australian Wheat Board Cockfield and Botterill 2007. This institution had the power to compulsorily buy wheat, assure a minimum price, set quotas when needed, and monopolize exports. A single authority would bring order to the unruly wheat market and thereby preserve farmer livelihoods. For many decades, the federal government took a strongly protectionist stance by imposing tariffs on food imports. Together, such policies constituted a 'stabilization regime' aimed at cushioning farmers from volatile global prices. Yet policy interventions were ad hoc, in response to pleas from farmer groups. As a result, several agrarian sectors (dairy, wheat, sugarcane, wool) received substantial public support while others (beef) did not (Pritchard 2005). Australia, therefore, had an institutional culture and politics predisposed to strong state intervention into agriculture.

As agricultural economists began advocating for policy reform and purposefully entering government departments to do so in the late 1960s and 1970s, the prevailing narrative changed to that of inefficiency and lack of competition (Baker 2018). The Whitlam Labor government's election in 1972 further destabilized the policy regime. It sought to jettison a cozy farmer-politician dynamic in favor of an impartial regulatory regime and "an injection of economic rationality" (Botterill 2003, 13). A new Industries Assistance Commission was established to oversee allocations of public aid to farmers, among many other producer groups. Farmer groups were forced to justify their requests according to the national interest, which was defined in economistic – not social – terms. Rural adjustment schemes were conceived to support only those farmers judged capable of longer-term productive futures. Those who could not produce economically should leave agriculture. In other words, the neoliberal revolution started in Australia earlier than elsewhere in the world.

In 1979, the National Farmer Federation formed after the merger of numerous associations focused on specific crops and animals. Since then, the NFF has represented industrial farmer interests more than family farmers (Botterill 2005). Across the next decade, the group lobbied for ever more liberalization of regulation and trade, asserting that free competition would benefit farmers. Their argument, reinforced by economists, was that producers would readily adapt to change and uncertainty, especially through boosting productivity,

using new technologies, and exploiting new markets. This orthodoxy has come to pervade agricultural policy discourse.

For the last 35 years, Australian governments have taken a staunch neoliberal approach to agriculture. In the 1980s, the Hawke/Keating Labor governments adopted 'economic rationalism' as their driving ideology (Pritchard 2005). These governments progressively stripped away regulatory controls, perceived market distortions, and import tariffs. They tried to prod the GATT regime toward freeing up global agricultural trade, which would supposedly advantage Australian farmers due to their greater competitiveness. Later, in the early 1990s, the advent of a national competition policy meant that state governments still using regulatory protections for farmers were pressed to have those reviewed (Dibden and Cocklin 2010). The Australian Wheat Board was privatized as a corporation that no longer served only farmers. The Howard Liberal/Nationalgovernment between 1996 and 2007 deepened the turn to privatization. It introduced the Agriculture Advancing Australia framework, which emphasized equipping farmers with financial skills, engendering improved access to markets, and making farmers 'ready to export' (Carey et al. 2016). It also foresaw a lucrative expansion of exports – preferably processed foods – to the Asian region, notably China. The Supermarket to Asia program aided would-be exporters to make marketing plans, study foreign markets, and connect into transnational supply chains (Pritchard 1999). This'government' program was designed and overseen by an industry-owned private company whose key shareholders comprised supermarket, farmer, and food company peak councils.

In contrast to the US, where the Farm Bill has provided extensive support for commodity farmers and some limited assistance for sustainable farmers, Australia does not provide substantial economic aid to its farmers (Lockie 2015). The country grants only 2% support to farmers, second lowest among OECD members, which mostly still offer substantial help (OECD 2015). Across the industrialized world, Australian farmers area mong the most exposed to market conditions. One exception to this state retrenchment is drought relief. Whenever a major drought materializes, the federal government announces a special fund to aid farmers (Botterill 2016). Another exception is an extensive research and development system that the federal government has built over the past several decades. While this system supports sustainable agriculture and climate adaptation work, it primarily aims to channel new technologies and improved crops and animals to farmers in the service of productivism (Carey et al. 2016). Australia now exports around 60–65% of its agricultural output. To expand this further, Australia has been busily making free trade agreements with numerous countries – notably the Trans-Pacific Agreement.

This neoliberal transformation has predictably led to farmers becoming far more vulnerable to international markets, volatile crop prices, and industry

pressures. The fact farmers have managed to survive is miraculous – yet seen as proof that competition is making the industry more efficient. The reality is that, as in the US, many farmers are struggling with poverty, debt, and corporate consolidation (Lockie 2015). Their industry association, the NFF, has hardly helped their predicament. The Australian supermarket sector is one of the most consolidated worldwide. For decades, two major chains – Coles and Woolsworth – have dominated the food supply (currently around 67% of the market: IBIS 2018) and have forced farmers to accept progressively lower prices as agriculture has become liberalized.

The situation is unlikely to change without government and industry commitments to vastly different priorities. The saga of trying to formulate a national food policy underscores this. In 2011, the Gillard Labor government began extensive consultations to make a plan integrating both nutrition and agriculture (Ridgway, Lawrence, and Woods 2015). Nonetheless, the process was captured by food industry interests and bureaucrats in the Department of Agriculture, Fisheries, and Forests. "Of the thirteen members of the [Food Policy] Working Group, ten were from the agriculture and food industries; there was just one consumer representative and one health representative" (Carey et al. 2016, 7). The Global Foundation (controlled by Woolsworth, the Australian Food and Grocery Council, the NFF, and CSIRO) oversaw the Food Security Working Group. It also argued, "with a forward thinking and comprehensive food plan, Australia has the potential to become a major exporter of high value-added food products" (Carey et al. 2016, 8). Not surprisingly, environmental issues and climate impacts on farming were sidelined in the final plan, despite being prominent in community/NGO and academic input throughout the public process.

After winning the 2013 election, the Abbott Liberal/National government swiftly abandoned this policy, and spent the next two years developing an "Agricultural Competitiveness White Paper" (Commonwealth of Australia 2015). The White Paper remains the country's main policy. Its content reveals the perceived appropriate scope of agricultural policy-making. The paper boasted: "The Government has laid the foundations for a stronger agriculture sector. We have reduced regulation, removed the Carbon Tax, increased export market access, invested in infrastructure and refined the settings for foreign investment" (p. 9). Most of the paper concentrates on strengthening the ability of farmers to compete globally. It praises the largest, most efficient, most profitable farms for investing in new technologies, land, and stock. Sustainability is confined to a few paragraphs. Only cursory attention is given to climate variability or change. The government does acknowledge the importance of soil conservation, improving water use, and regulating pests and weeds.

Climate, technological hopes, and science

Australia is poised for even harsher environmental conditions. The country will become one of the worst affected by climate change worldwide unless carbon emissions are reduced sharply. Even with reductions, climate impacts already have tremendous momentum that will be difficult to escape. In response, governments, industry, and scientists are emphasizing technological solutions as a preferred strategy. These elements both continue existing feedback loops that reinforce an industrial agriculture pathway, and magnify loops of environmental decline as an emergent new lock-in.

Much of Australia faces an even drier and hotter future because of climate change. The inland regions of New South Wales and Queensland are experiencing their driest conditions since the last mega-drought, the Millennium Drought between 2003 and 2011. The *Guardian Australia* newspaper has tracked these conditions. One of the families whom its reporter spoke with, Doug and Rachelle Cameron, are barely surviving in cattle farming. "Their 34,000 acre station, Nive Downs, is 750 km inland from Brisbane in south-west Queensland and they are facing their fifth year of drought. For the Camerons, the big dry started after the floods of 2012. Like most diligent farmers, they have tried to cut down their herd to take pressure off pastures and ensure they don't need to spend too much on feed" (Chan 2018). The following year, other *Guardian* reporters wrote, "Girilambone, population 26, is already part of the way towards becoming a ghost town but this drought could be the last straw. The town water supply ran out six months ago and water is now trucked in every two days" (Davies, Smee, and Allam 2019). As of 2019's end, dams across inland New South Wales were almost empty. Farmers are not planting or hiring workers, which means that small rural towns face even more financial trouble. Families are moving away, leading to school and medical care closures.

Recently, several scientific reports have explored future environmental trends through modeling (e.g. Hughes, Galeano, and Hatfield-Dodds 2019; Hughes, Lawson, and Valle 2017). Wide agreement exists regarding the likely negative patterns of climate impacts. The Melbourne Sustainable Society Institute (2015) suggests that the inland will become much warmer – potentially increasing by 5 degrees by 2070. The Mediterranean zones in south-west Western Australia and the Barossa Valley of South Australia will experience fewer cold days and nights required for vernalization of many current tree crops, a doubling of days above 35 degrees Celsius by 2070, and less rain in winter. More bushfires and droughts are foreseen for the cool temperate zone of south-eastern Australia, home to most of the country's vegetable harvest. (The vast bushfires of summer 2019–2020 may be a harbinger.) Fewer but more intense cyclones and rainy periods may affect agriculture in the tropics. In general, more heatwaves and more extreme weather events – such as

flooding and storms – can be expected across Australia. Soils will lose more moisture with higher evapotranspiration rates and less rain. Hughes, Steffen, and Pearce (2015) suggest that hot/warm climates will move 900 kilometers southward by century's end.

Those changes mean that numerous crops and animals are already affected in their production. For two centuries, sheep has been a mainstay of Australian agriculture; now, farmers are struggling to produce wool (Harle et al. 2007). Hughes, Steffen, and Pearce (2015) note cattle may suffer heat stress and require feed because pasture growing seasons will shrink. "The yields of many important crop species such as wheat, rice and maize are reduced at temperatures more than 30°C . . . Heat stress reduces milk yieldby 10–25% and up to 40% in extreme heatwave conditions." (p. 5). Warmer weather harms the flavor, texture and physical structure of carrots. Onion bulbs will start growing earlier, limiting their size, and will have a shorter harvest window. Higher carbon dioxide levels may mean lower protein and mineral content in plants. Weeds, diseases and pests will spread beyond their existing ranges, as well as vector-borne diseases that may affect farmers and workers. As a result, Australia would be one of the worst-off countries when it comes to agriculture (Daly et al. 2015).

Popular ideas for adaptation include finding hardier animals that can tolerate heat better and varieties of established crops that can survive drought and salt (Australian Academy of Sciences 2017; Hughes, Steffen, and Pearce 2015). These new organisms, however, might have lower yields and be less nutritious.Climate scientists also suggest that farming areas may shift geographically. For example, Tasmania may become a more significant agricultural state because it will remain temperate. In contrast, parts of Victoria and New South Wales may be unable to produce fruits and nuts because they are too hot in summer.Little attention appears to be given to whether indigenous plants and animals might provide more resilient replacements for the dominant 'European' suite.

Other adaptations may occur through dramatic landscape manipulation. New South Wales has been reviving dormant plans to – perhaps – divert rivers further inland and to crisscross its land with huge pipelines (Davies 2019b). The Morrison Liberal/National government is contemplating larger dams along the eastern seaboard. Of course, these solutions depend on there being reasonably reliable rainfall. The Abbott/Morrison governments have also resurrected old talk about turning northern Australia into a food bowl for Asia (e.g. Law 2013). During the monsoon season, vast storms can inundate this terrain, leading to perceptions of the region's seeming fertility further south. This idea would entail building massive irrigation schemes, dams, and railways. It would also call for finding compatible crops. The government has already created an infrastructure fund aimed at developing northern Australia. Yet, the vision disregards how early efforts to introduce intensive farming have

foundered, as in the Ord River scheme of the 1960s on the Kimberley plateau (Anderson 2013). Northern Australia has fragile ecosystems, floodplains, and poorer soils. The rivers are often ephemeral.

To manage a rapidly changing environment, many university scientists, industry leaders, and government officials are seeking technologically optimistic solutions. Robotics is drawing much interest for its promise to resolve the problem of dwindling farm worker numbers. Engineers at the University of Sydney are inventing robots to help herd cattle and harvest small-scale vegetable plots (ABC Catalyst 2018).The dairy industry points to the first robot milking sheds as evidence it can compete globally (Daly 2016). Glasshouse hydroponics is also starting to draw attention, with experiments attempting to develop more efficient artificial lighting and to use sensors to accelerate the selection of plants that meet design specifications (ABC Catalyst 2018). Australian scientists aresearching the planet for samples they can test and breed – possibly edit with CRISPR-Cas9 – for local conditions.

This burgeoning interest aligns with a tradition of scientific agriculture. In the 1900s to 1930s, state governments often promoted use of science to manage farmland, believing that this would help overcome environmental constraints (Keneley 2002; Muir 2014). Crop farmers were encouraged to use fertilizer to nourish their soils. An extension system emerged across the country. Field stations were built to trial crops and farming methods. While nowhere like the US extension infrastructure, these stations did help cultivate an ideal model of farmers using the latest scientific knowledge. Later, soil conservation programs developed in each state, aiming to use scientific techniques to restore eroded soil and stop salt mobilizing. In recent years, however, state governments have mostly retrenched their extension and R&D programs because of the prevailing neoliberal discourse (Higgins, Dibden, and Cocklin 2012). To some extent, the private sector has stepped in. But the federal government's network of cooperative research centers and rural research corporations currently provide most agricultural science.

Scientific and technological innovations are seen as assuring Australia's long-term prosperity. In 2015, the Australian Council of Learned Academies (which unites the scientific, humanities, engineering, and social scientific associations) produced a report that shows the farms that dominant technical experts want to promote. "Farms of the future will be unrecognizable. The most-profitable farms today already have greater access to modern, advanced technologies. . . . Farmers will use real-time information to tailor farm management of inputs to maximize yield and quality of outputs. Automation will continue to grow and robots will harvest and prune, drones will survey fences in pastoral leases and check for problems in high-valued crops. Tractors are already computers on wheels" (Daly et al. 2015, 20).This report is part of a series that provides evidence-based, interdisciplinary knowledge to support policy development in areas of importance to Australia's future.

In 2016, the Australian Academy of Sciences also released a decadal plan for Australian agricultural sciences. Its emphasis is on expediting the ready flow of new technologies into farms. "While there is considerable merit in applying precautionary principles, the ability of agriculture to respond to the challenges of the 21st century and deliver the triple bottom line requirement of profitability, productivity and sustainability may be significantly impaired if technologies that can revolutionize production are sidelined" (Australian Academy of Sciences 2017, 10).The National Farmer Federation shares many of these views in a 2015 report outlining its vision for Australian agriculture. "A fit-for-purpose regulatory environment that manages risk without hindering access to safe technologies. World class access to technology." (National Farmers Federation 2015, 26). The tenor of this scientific discourse is productivist. Even though a sustainability thinktank, the Climate Council (2015) calls for an overall goal of doubling production per unit area for crops and animals. This intensification will use resources more efficiently and sustainably. Such norms and visions are widely shared across the Australian agricultural science/policy community.

Summary of lock-in effects

In sum, as seen in Table 1, numerous socio-ecological and political economy lock-ins pervade Australian agriculture. The landscape has been transformed in a way that both provides farmers with fewer resources to use in agroecology, and requires so much work to regenerate that the vast majority of farmers – facing poverty and competitive pressures – are not able (or willing) to do it. Indigenous knowledge that could help remake the landscape has been made invisible. Elite politician, policy-making, and scientific groups are stuck in an industrial mode of thought, and oblivious to (or dismissive of) the agroecological experiments taking place. The food industry wields so much power over policy and supply chains, that it is hard for alternatives to be taken seriously. Climate change can create further lock-ins through making it more difficult for farmers to survive in some regions, and by weakening rural communities even more.

Crucially, the S&T knowledge required for the future does not include ecological farming, place-based agriculture, or resurrecting indigenous crops and animals. Mainstream scientists make it challenging for agroecological practices to be appraised on the same level as industrial practices. Federal governments, both Liberal/National and Labor, are hostile toward the concept of ecological farming. With the exception of supporting the Landcare movement (see below) and looking into carbon sequestration through healthy soils and ecosystem services, governments neglect the ecological dimensions of agriculture. In general, the scope of options for the future seems confined.

Openings for an agroecological transition

How can agroecology take root in Australia? What openings exist for instigating a transition that can burrow through the entrenched lock-ins of colonial history, policy systems, industry power structures, land/environmental change, and scientific paradigms? Many experiments with agroecological methods are already happening locally throughout the country, as farmers desire more resilient alternatives to industrial agriculture (see e.g. Arias, Jonas, and Munksgaard 2019; Cross and Ampt 2017; Massy 2018). Using the MLP framework, these developments are at the isolated niche level. Simultaneously, parts of the landscape scale are changing, especially climate and economic trends that threaten the existing productivist agriculture regime. But the niche developments cannot change the prevailing regime without attending to why lock-ins exist and how they are negated. For such experiments to transform the regime, we need to see how settler colonialism, neoliberal ideology, S&T priorities, and other elements that help hold the regime in place could be disrupted or loosened to allow alternative pathways to become more feasible.

In addition, the MLP needs to include cognitive, political, and social processes that might help niche developments scale out in ways that can transform the regime. This is where Mier Y Teran Cacho et al. (2018) can help, by sketching how transitions can happen through 'massification' or 'territorialization' of agroecology. They "identify eight key drivers of the process of taking agroecology to scale: (1) recognition of a crisis that motivates the search for alternatives, (2) social organization, (3) constructivist learning processes, (4) effective agroecological practices, (5) mobilizing discourses, (6) external allies, (7) favorable markets, and (8) favorable policies" (p. 637). All of these drivers are needed in Australia; I will work through each one, including lock-ins. Table 2 summarizes what these drivers might look like. They must be adapted to the Australian context because the underlying analysis was based on peasant farmer-led transformation in developing countries.

Massification and unwinding lock-ins need to happen at multiple scales across Australia, which is a large, geographically varied continent. For example, individual farmers, local communities, rural regions, urban centers, states, and the nation are all part of the agri-food system. Actors at each scale can carry out actions, measures, and policies that (1) practice or support agroecological methods and (2) challenge settler colonialist legacies, according to their capabilities, power, and jurisdiction. Massification starts with individual farms and local networks of farmers, expands to multiple regions and cities, and eventually reaches nationwide.

Recognition of crisis

An agrarian crisis clearly exists in Australia: many farmers are facing the effects of drought, industry consolidation, and the failings of export-oriented

Table 2. Summary of possible massification drivers in the Australian context.

Massification driver	Australian situation
(1) Recognition of a crisis that motivates a search for alternatives	Decline of rural economies. Climate change impacts on crops and livestock. Lengthy droughts. Widespread farmer questioning of status quo.
(2) Social organization	Weak agroecological movements as yet. Food sovereignty movement still nascent. Landcare as possible base for expanded farmer movement.
(3) Constructivist learning processes	Small number of farmer-to-farmer learning networks. Landcare as key precedent and repository of experiences/local knowledge.
(4) Effective agroecological practices	Numerous experiments with agroecological and regenerative practices. Resurrection of Indigenous agricultural knowledge. Dry-farminginnovations.
(5) Mobilizing discourses	New discourses needed: Australian agroecology as more flexible and adaptive to rapidly changing environments; safeguarding nation's food system.
(6) External allies	Need to recruit supportive allies in academia; environmental NGOs; food businesses; governments. Some allies already: e.g. Mulloon Institute and several universities with regenerative farming programs.
(7) Favorable markets	Developing market for organic food that could support agroecology. Weak direct marketing channels. Potential for peri-urban agroecological markets.
(8) Favorable policies	Need state and federal governments to prioritize agroecology in policy-making; revive rural welfare; rebuild city and rural food systems.

strategies. While some large, wealthier farmers and corporate farms have benefited greatly from intensification, technology use, and public support for exports, the majority of farmers have endured years of volatile or declining livelihoods and growing debt burdens (Alston 2004; Lockie 2015). Depending on the production sector, large numbers of farmers have exited agriculture since the 1980s. The remaining farmers suffer from mental and social stresses, decaying rural towns, and worsening ecological degradation. The first effects of climate change are only compounding these pressures (Hughes, Galeano, and Hatfield-Dodds 2019; Hughes, Lawson, and Valle 2017).

Historically, farmers have taken an extractive – often warlike – attitude to their land (Muir 2014). A strong norm of industrial agriculture has discouraged deep exploration of sustainable approaches, particularly those making farms look radically divergent from what a farm 'should' look like (devoid of trees and weeds, introduced plants and animals, heavily fertilized, hard-soiled, free from biodiversity). Since the 1980s, when climate change science began to enter policy discourse and public awareness, most farmers have rejected the idea that climate change is happening and will intrude on their everyday lives (Wheeler and Nauges 2018). Drought has been part of their patrimony. But more farmers are searching for viable alternatives to the status quo. The small, but growing, number of successful agroecological (or 'regenerative agriculture') farms dotted across the country are piquing their interest – especially if the farms are visibly surviving while their own is not.

More farmers are also acknowledging that they must contend with climate change. Farmers increasingly speak about shifting rain patterns, more extreme fires and increased drought severity (Baker 2019; Hampel 2015). Some are losing sizable chunks of their crops or herds in a matter of days Davies, Ball,

Evershed 2019. This world is opening a new space in which formerly controversial opinions (among farmers) are becoming normal. Will Graham, a Queensland Central Highlands cattle producer using pasture, says, "Five, 10 years ago, no farmers would've believed in climate change – they were saying these are just weather cycles. Now they accept it, they talk about it – and they want action" (BBC News 2019). A new group, Farmers for Climate Action, emerged in 2016 to gather concerned farmers and press governments for policy change Farmers for Climate Action, 2019. It already has over 5,000 members. Its former head, Verity Morgan-Schmidt, asked "Who better than capitalist conservative farmers to push the government on climate change?" (BBC News 2019). Even the National Farmer Federation has belatedly begun saying that climate change poses substantial risks to production. Its president, Fiona Simson, states: "Overwhelmingly, I think it's got to the point where the science is very acceptable" (Murphy 2018). Previously, the NFF had vigorously opposed efforts to create a carbon price. Not surprisingly, this organization now calls for market-based schemes to reward farmers to protect biodiversity and ecosystem services. Still, where conservative farmers are bending, more open-minded farmers are trying to implement regenerative farming. Crisis, then, is creating new openings for agroecology.

Effective agroecological practices

Many potential practices exist but require extensive rethinking of what sorts of agriculture can be used in this continent. Several broad changes can make agriculture more agroecological. Farmers can identify and use crops, animals, and trees that are better suited to Australia's environment and climate, now and in future, instead of the dominant suite of European organisms. They can apply ecological principles to managing farms and grazing land, without relying on industrial inputs. Farmers can purposefully include indigenous biodiversity in their agroecosystems, rather than expelling it in maximizing production. Farmers can also develop practices attuned to the hydrology, soils, and ecologies of their places. For example, flows of water, matter, and energy on contemporary farms often diverge vastly from what existed 'naturally'. Prior to the disruptive impacts of colonization, much of this landscape had already been shaped through prolonged Aboriginal land use practices, as well as millions of years of environmental processes.

However, farmers must adapt agroecological principles to the diverse environmental conditions prevailing across Australia's many regions. They may have to redesign certain practices that function effectively in areas with highly fertile soils, abundant biodiversity, and consistent rain. Organic farmers have learned that trying to stimulate nutrient flows can be counterproductive in the poorer soils present in some regions (Conacher and Conacher 1998). Given the collapse of biodiversity in Australian farm landscapes, agroecologists may be unable to draw on endemic insects, animals, and plants to regulate invasive

pests and weeds. This means that trials with organisms that have proven highly effective in other world regions may have to be carried out. Successful experiments with biological control have previously occurred for the prickly pear, rabbits, and mimosa (Cullen, Julien, and McFadyen 2012). But there are implications for Australia's stringent biosafety regulatory regime and for the long history of imported organisms that proved to be destructive (Low 2002). In the longer term, agroecologists may struggle to succeed under extreme conditions, such as summer heat withering crops and harming farmworkers. Agroecological farms – like conventional farms – could be physically confined to more equable areas, although some evidence (see below) suggests this need not be the case.

Several sources of inspiration can inform the making of a distinctively Australian agroecology. One is the agrarian heritage that Aboriginal peoples are now reclaiming. Pascoe (2018) surveys what Indigenous story-telling, settler journals, and explorer diaries tell us about the kinds of crops, animals, and fishes that Aboriginal peoples across the country farmed. He describes a large diversity of tubers, grains, leafy plants, and fruits, such as native sorghum, wannum, native oatgrass, murnong (or daisy yams), and millet. Pascoe (2017, p. 67) writes, "The great advantage of Aboriginal crops is that they have been developed through seed selection, direct planting, and weeding for the harsh conditions of Australia", perhaps over 50,000-plus years.

Importantly, many of these crops were formerly grown in what appear to be particularly inhospitable lands – much of the inland, stretching from the Kimberleys in Western Australia to the Flinders Range in South Australia and into southwest Queensland. The peoples living in this vast region called themselves 'panara people', or grass people. Other peoples raised native rice in northern Australia. Many native grains can survive on sand, while kangaroo grasses can live on marginal drylands where grain and sheep farming has been abandoned. Nardoo grew on the beds of shallow lakes in arid areas; once the lakes dried, local Aboriginals could sweep the seed into stockpiles. Yams used to thrive in much of Victoria, in grasslands that women would harvest. Some evidence of the use of polyculture exists: yams, kangaroo grass, and mosses were often cultivated together. Aboriginal peoples also used 'fire-stick farming' to allow native plants to re-grow and to regulate the movements of kangaroos, emus, and other animals for harvesting or to stop them eating crops (Gammage 2011). Some Aboriginal communities are now working to re-discover their heritage. The murnong was lost in Victoria until remnant meadows were found; local groups are trying to regrow this yam near Mallacoota, and to develop cultivating, processing, harvesting, cooking, and marketing knowledge suited to the contemporary food system. In other world regions, agroecology includes rescue of native seed varieties and animal breeds, and this can cross over into mainstream agriculture.

Another source of inspiration is the efforts of a growing number of farmers to fashion practices of landscape design that cooperate with Australian soils, water cycles, and climates. Their work forms much of the niche for agroecology in this country. Massy (2018) traces the hidden history of agroecological experiments dating back to the 1940s, if not earlier. Water availability is fundamental to any agriculture in Australia – including agroecology. Here, Australian farmers are among leaders worldwide in finding ways to help landscapes retain water. The vast majority of farms have been cleared of native vegetation, repeatedly plowed for crops, set-grazed with livestock (i.e. fixed numbers of animals, no matter the conditions), fallowed in between crops, and subjected to infusions of phosphate fertilizers. Their soils have often become hard, compacted by hooves, and lacking in moisture. This dead soil cannot hold water even when it does rain.

During the 1940s, using his NSW farm, P.A. Yeomans developed the Keyline plan for regenerating farms, which inspired some farmers in subsequent decades. He argued that holding water *in* the landscape – not rushing it off – was essential to successful farming. He built contour channels across a farm, to capture water and move it into storage dams. Tree-breaks were planted along these channels. Yeomans also adopted a chisel-like digging technology to gradually go deeper and deeper into subsoil without turning it over (similar to Aboriginal digging practices). This promoted water and root entry while forming air pockets in the soil. Rotational grazing and mulch-mowing increased the growth of soil organic matter. As a result, Yeomans could transform nutrient-poor soil into biologically living soil within a few years. In 1954, he published one of the first books on sustainable agriculture worldwide – but encountered deliberate suppression and discrediting from the agrichemical industry, agronomists, and government officials.

Peter Andrews is another NSW-based farmer who is known for his advocacy of rebuilding hydrological health through what he calls Natural Sequence Farming (Andrews 2006, 2011). To rehydrate a landscape, he builds on the Keyline plan and plants trees, scrub, and weeds along contour lines. He makes 'leaky weirs' out of rocks and tires to slow water down in existing creeks, as well as chains of ponds filled with indigenous Phragmite reeds and perennial grasses. He contends that some (not all) Australian regions used to have chains of ponds and undulating land that could store a modicum of water. Some Aboriginal peoples also used this approach. To deal with salinity, a freshwater layer can be re-created underground to trap an underlying saline layer.

Massy (2018) suggests this approach might not succeed in areas where soils are extremely compacted and water is scarce. To address this challenge, NSW farmer Peter Marshall emphasizes nurturing lateral water circulation *across* the farm, not just along creeks (Massy 2018). He takes a similar ponded system approach to Andrews but uses multiple channels and side-channels to spread the water flow more. He relies on berms of Phragmite reeds, which seem to be the keystone

species in this habitat. If necessary, Marshall will do strategic soil ripping with a Yeomans digger or even explosives in drilled holes, to eliminate compaction and remake capillary tubes radiating out from aboveground or underground sources of water. Much evidence exists as regards the efficacy of such agroecological methods: compared to their conventional neighbors, regenerative farms looked lush and maintained significant, if lower, production during the Millennium Drought.

Importantly, some of these agroecological experiments are happening on huge grazing farms in extremely difficult environments. For example, short, intense, high density grazing in tens of 'cells' on a cattle or sheep station can weaken soil compaction and reinvigorate indigenous grasses and flowers (Massy 2018). With expanding ground cover, weeds struggle to grow, while parasitic wasps regulate grubs that eat pasture. Allowing the most eatable plants to rest for some of each year means they are not eradicated by livestock. Soils can store much more water, making such farms more resilient during droughts. This idea of 'cell grazing' comes from Zimbabwean grazier Allen Savory (Savory, Butterfield, and Bingham 2019). It can be combined with building a highly distributed water system in which bores, pipes, and troughs are installed across the station, which agroecologists do not traditionally do. But it is needed in the vast 'outback' stations of Western Australia, Queensland, and the Northern Territory. Tree shelter belts can also be made across a station. Even though apparently less land is available for farming, the remaining land may be more productive overall.

As well as learning from Aboriginal peoples, ideas for dry, biodiverse farming can be adapted from other places. Indigenous peoples elsewhere have often created effective farming systems in the kinds of environments found in Australia. Peter Marshall, for example, was inspired by the Hopi and Zuni peoples' use of cienagas, or aerated water meadows connected to seeps in New Mexico and Colorado. He also drew on the chinampas system of Mexico in designing islands to provide biodiversity refuges in his ponded system. These collective experiments, however, mobilize just a few principles of agroecology. Other principles could be developed much more, depending on geographical location. In short, much material for agroecological practice-making already exists in Australia, but requires challenging the legacies of settler colonialism and Euro-centric visions of agriculture in order to be recognized and put together into suites for many more farmers to adopt.

Social organization and constructivist learning processes

Mier Y Teran Cacho et al. (2018) note that social organization may be the most important driver of massification. Social movements, farmer networks, field school systems, and other ways of organizing people into collective action can greatly accelerate the growth of agroecology across a territory (see also Brescia 2017). Many such organizations are founded on, and help generate, learning about alternatives to industrial agriculture. The *campesino-a-campesino*

movement in Mesoamerica and Cuba illustrates this synergy: peasant farmers devised their own pedagogy for experiential learning, relied on farmer-educators (or 'promontores') to share lessons, and formed an organization to amplify their work more widely. Holt-Giménez (2006) notes that farmers are more likely to trust in other farmers as sources of knowledge. Visiting farms with successful agroecological practices can enthuse uncertain farmers to start experimenting on their own farms.

In Australia, social organization is, uniquely, both embryonic and advanced. No distinctively agroecological mass movement exists yet, and grassroots farmer organizations like those of Central America, Cuba, and Brazil do not exist at a large scale. Australia is not yet sturdily connected to the agroecology movements of Latin America, limiting cross-fertilization from other world regions (Mann 2019). The NFF generally represents more intensive, larger farmer interests. Nonetheless, local networks of sustainable farmers have been important in disseminating knowledge for decades. For example, the Otway Agroforestry Network began in 1993, when several farmers in the Otway mountains southwest of Melbourne became interested in planting diverse trees in places where these could protect soils, watercourses, and other features – and, later, be harvested without damaging the farm (Massy 2018). Over 200 members are now active in the network, which has catalyzed the Australian Master TreeGrower Program. Consultants have transmitted knowledge through training programs and seeded networks of farmers who have adopted their various approaches. Over 20 years, the Queensland-based Resource Consulting Services group has taught over 7,000 farmers in the techniques of holistic pasture management and the Rural Profit System (Massy 2018).

Organization for political impact is only beginning to materialize. In 2011, the Australian Food Sovereignty Alliance formed in response to the exclusion of community, small farmer, and public health perspectives from the National Food Policy consultation process. Inspired by the principles of La Via Campesina, a movement with 150 million peasant farmer members worldwide, the group led the making of a "People's Food Plan for Australia" to inform the 2013 federal election (AFSA 2012). This plan features agroecology and food democracy at its core, and invokes Miguel Altieri's works and former UN Rapporteur on the Right to Food Olivier de Schutter's reports as resources. The ASFA remains small in membership but has already established a strong presence in international activist spaces. Recently, the alliance published a book with stories authored by 10 farmers representing experiments with agroecology and direct marketing (Arias, Jonas, and Munksgaard 2019).

Yet Australia has an unusually rich heritage of farmer-to-farmer learning, through the nationwide Landcare movement/program which began in Victoria during the mid-1980s and peaked around 2000. Landcare aspired to change farmer attitudes to land degradation and to nurture greater stewardship, through creating local groups, granting limited public funds, and

sometimes providing coordinators to gather people together and run activities (Curtis and De Lacy 1996). The idea was that farmers would better manage complex land problems jointly, instead of just individually. Campbell (1998) analyzes how Landcare groups became spaces for social learning, observing experiences through field days and farm walks, and carrying out tests in their own conditions. Typically, groups would plant trees, build structures to control salinity and erosion, install fences to control stock access to creeks, manage weed and pest control at landscape scale, and establish wildlife corridors (Curtis and De Lacy 1996). Such groups were largely farmer-led and driven, in contrast to the traditional state government land conservation agencies that sent soil scientists out to study problems and advise farmers. By 1998, there were 4270 Landcare groups involving over 30% of Australian farms, depending on the region(Sobels, Curtis, and Lockie 2001).

Extensive research into the Landcare phenomenon suggests that a nascent social movement was indeed forming around this government/farmer program. The groups were certainly important in helping stimulate greater knowledge about land degradation and about various management practices through farmer-to-farmer exchanges. Being a Landcare member made it more likely that farmers would adopt these practices, compared to neighbors who were not in Landcare (Curtis andDe Lacy 1998). But many farmers did so because of the economic costs of land erosion and salinity, not because they had developed a new stewardship ethics (as was the program's aim). Larger, wealthier farmers also participated more in Landcare than their smaller, resource-strapped counterparts. By the late 1990s, the movement had developed to the extent that groups began joining together to form 'Landcare networks', such as the Holbrook Landcare Network in NSW, the Woady-Yaloak Landcare Network in Victoria (Sobels, Curtis, and Lockie 2001), and the Tasmanian Landcare Association. Some of these networks were well-funded, politically connected, and could support their groups with staff.

Since the mid-2000s, however, Landcareh as atrophied due to lack of public investment and competing administrative structures, highlighting the pitfall of over-reliance on fickle government aid (Tennent and Lockie 2013). Government staff have wrestled back control over funds and direction. In the extreme drought era, many farmers are focused on trying to survive, and have been less able to draw on their own resources. The program itself was a case of neoliberal governance: the Hawke/Keating government saw Landcare as a means to devolve environmental care to communities and volunteers, a view that subsequent governments upheld. Landcare was somewhat narrowly focused on land degradation, tied to productivism, and did not emphasize ecological farming methods. That said, many farmers who are now reshaping their land to restore water, soil, and ecosystem functions were involved with Landcare at some stage (Massy 2018). Landcare still exists and could be a substrate for social organization toward agroecological transitions. If the farmers now testing

agroecological practices could be connected into a coherent movement across the country, and many more could be recruited into this network, this could help propel transitions powerfully. The Farmers for Climate Action group is one possibility. This could go far toward unwinding many of the political economic and socio-ecological lock-ins.

Mobilizing discourses

Why would agroecology provide an answer to the continent's problems? In the prevailing neoliberal and technologically optimistic milieu, ecological farming seems rather anachronistic and inefficient. Mier Y Teran Cacho et al. (2018) say that mobilizing discourses"allows the definition or framing of a common problem, a shared adversary, a horizon of struggle, a common identity, and common principles" (p. 649). These discourses use agroecology – in terms of local cultural, spiritual, and historical contexts – as a way to frame the labors of farmers (1) against the dominant industrial agriculture regime and (2) toward ecological farming. They help motivate farmers to begin and continue experimenting with agroecological practices.

In Australia, agroecology remains little known in contrast to organic food and, now, 'regenerative agriculture'. Regenerative agriculture is increasingly invoked to describe the activities of farmers like Peter Marshall and Peter Andrews. It does share many ecological practices with agroecology – but differs in that the latter is not just 'practice' but is also 'science' and 'movement'. In the US, regenerative agriculture is associated with finding ways to marketize ecological farming practices (e.g. by making carbon credits for soil health, or by selling products to companies like Patagonia Provisions: Rosenzweig et al. 2017). This commercial discourse is also appearing in Australia. By contrast, agroecologists emphasize the political nature of agroecology and the need to change the larger food system itself. When discussing agroecological transitions, Gliessman (2016) suggests that mature agroecological efforts involve the making of alternative food networks that directly connect farmers and eaters ("Level 4"), and ultimately the making of a global food system based on equity, participation, democracy, and justice ("Level 5").

New discourses, then, need to be made for Australian agroecology that will excite and draw in farmers, scientists, consumers, policy-makers, and companies that are accustomed to industrial agriculture. These discourses should break down the 'thick legitimacy' of industrial food and thicken the currently thin legitimacy of agroecology (Montenegro de Wit and Iles 2016). They could include debunking the dominant model of intensive, technology-based farming as inefficient, very costly to farmers and Australian communities in general, and outdated in a fast-changing world. As Lawrence, Richards, and Lyons (2013) show, this model is putting Australia on a locked-in path toward deteriorating environmental conditions and food access. While policy-

makers portray Australia as a food-secure country that can export most of its production from crops and animals, significant hunger and food insecurity exists among Aboriginals, recent migrants, poorer communities, and rural people (Ridgway, Lawrence, and Woods 2015). As farmers become more receptive to climate arguments, agroecology could be framed as an important adaptation process for climate change that works faster and more flexibly than any technological solution could hope to.

What is even more important is creating a different, non-extractive understanding of how agriculture relates to place. Australian farmers could work to invent a truly Australian farming approach that acknowledges the legacy of colonial destruction, builds on Indigenous agrarian knowledge, and revives the ecologies and water flows that used to characterize the continent, as best as possible in a climate-changed world. This would constitute a different way to experience and visualize the land – similar to how Aboriginal peoples use 'country' to describe the land they are responsible for managing. Indeed, it *is* indigenous in its inspiration and nature. This is why cosmovisions should be part of the definition of agroecology, along with science, practice, and movement.

External allies

Mier Y Teran Cacho et al. (2018) point to the importance of allies that provide support to peasant agroecology movements. Those allies can supply material resources such as money and staff, ethical narratives, political connections, access to the media, and knowledge about applying for public grants. Each movement has its own allies, reflecting its political, cultural, and historical context (Brescia 2017). In some places, religious institutions may be key allies; in other places, technical associations and land movements may be critical partners. In the Australian context, achieving thick legitimacy for agroecology is a profound challenge. Here, possible allies include scientists; environmental and consumer NGOs; universities; supportive foundations and business people with substantial resources; sympathetic government officials; and alternative food markets. Much work must be done to recruit, educate, and inspire those actors, regarding the legitimacy of agroecological knowledge. They may then help mobilize resources to boost agroecological movements, spread practices, and change government policies.

For example, some farmers are collaborating with university scientists to validate their agroecological practices at the individual farm scale. Peter Andrews is endeavoring to recruit agricultural scientists, soil experts, and ecologists to testify to the benefits of adopting his farming system (Andrews 2011). Such scientists can help build greater legitimacy through publications, grants, and contacts with government officials. At the same time, scientists and policy-makers must recognize farmers and pastoralists as being legitimate producers of knowledge in their own right. A large part of the reason why

ecological farming has struggled to expand beyond the niche level is the resistance of technical experts to farmers having their own, place-based, observational wisdom. But it is farmer-scientists who are busily inventing the ecological and rehydration techniques of Australian agroecology, not traditional agronomists and modern agricultural engineers. "People's knowledge" (Anderson et al. 2017) should be central to agricultural science.

Other ecological farmers are already working with influential business leaders to share their practices more broadly. For example, a wealthy businessman, the late Tony Coote, founded the Mulloon Institute to expand the use of landscape rehydration projects across the continent (Rutherfurd 2018). Inspired by Peter Andrews' work in transforming his farm at Mulloon Creek near Canberra, Coote began drawing in 20 other landowners along Mulloon Creek to build a catchment-scale project. He recognized that the dominant agricultural and environmental science disciplines have been skeptical toward ecological farming. Thus, the new institute seeks to carry out scientific studies, baseline surveys, and monitoring over time to measure how specific practices are performing and whether rehydration is occurring (Mulloon Institute 2019). It gives opportunities to students from the Australian National University to do research in this area. The institute has a goal of facilitating 100 new rehydration projects across Australia and has a growing training program.

Environmental NGOs could help amplify agroecology as a viable alternative through their members, projects, and community networks – but need to learn much more about what agroecology entails. The Australian Conservation Foundation has been a largely unadventurous group in this arena but did boost the Landcare movement in the late 1980s. Choice publishes a well-known consumer rights magazine that regularly criticizes industrial food products, but has hardly touched ecological agriculture as a source of better foods.Climate scientists could also play a vital part, given their emerging status as ethically powerful voices at a time of policy malaise. In Australia, universities occupy an important intellectual space for shaping wider public and government discourse. While most agricultural schools and colleges have been dedicated to productivist methods, a few schools – like Charles Sturt University in NSW – have set up small agroecology programs (Cochrane, Anantanarayanan, and McKenzie 2007). The Southern Cross University has established an undergraduate degree course in Regenerative Agriculture. If more agricultural schools – along with policy, law, public health, and social science units – devoted more teaching and research resources to agroecology, this would provide an alternative to the prevailing technologically optimistic mind-set.

Government departments – particularly for agriculture – have been hostile to ecological farming, especially during the neoliberal decades. Still, sympathetic government officials and scientists could be recruited in state

government agencies to try to begin changing internal norms and beliefs. As I discuss below, some more environmentally minded state governments could introduce their own policies to encourage agroecology – but profound changes in their understandings of agriculture, willingness to embrace land-based solutions (as opposed to technological fixes), and relations with rural communities would be required. Victoria seems the most likely site for this change because of its recent history of social activism and strong/diverse food culture. If governments in South Australia and Tasmania change, these states might also be hospitable for the same reasons. Even within more development-oriented states like Queensland, WA, and NSW, local areas can choose to prioritize agroecology.

Favorable markets

Under conditions of weaker social organization, creating new markets for food produced through agroecology can provide a critical boost to encourage more, economically-minded farmers to switch from conventional methods. These markets can educate consumers that agroecology exists. They can challenge dominant outlets that prioritize industrial, processed foods. Such markets may develop through alternative food networks, institutional procurement systems, direct-to-consumer models like community-supported agriculture, and certification schemes. In other places, markets have proven crucial to agroecology's expansion. For instance, Brazil has a few local and regional markets based on solidarity principles. The country had a Federal Food Acquisition from Family Farming program that purchased food from agroecology farms for use in schools (Wittman and Blesh 2017).

In Australia, by contrast, alternative food networks are still taking form. A number of farmer markets exist in the cities but these are not as visible or established as in the US. Regenerative farmers sometimes try to sell to restaurants and stores wishing to stock sustainable food. Some farmers are experimenting with their own on-site outlets if they are in a location where urban consumers can pass by or take holidays (Arias, Jonas, and Munksgaard 2019). Organic food has been becoming more popular for the past 15 years, with many smaller processor firms making products and supermarkets starting to offer their own lines. Australia is one of the world's largest organic agriculture countries by acreage, but this can be largely attributed to grass-fed meat. A few other eco-labels, such as 'cage-free eggs', have developed to stimulate markets for consumers concerned about animal welfare and sustainability (Parker et al. 2017). But regenerative agriculture – let alone agroecology – has hardly reached the supermarket aisle. Unless food retailers purposefully choose to source and promote (affordable) agroecological foods instead of pursuing cheap food strategies, this situation is unlikely to change. Much room thus exists for creative marketing approaches. In Australia, local governments,

schools, and universities could play leadership roles in catalyzing smaller markets through their sourcing and food system policies.

The scale of rural Australia is vast and poses challenges for transportation and marketing. Many parts of the country have low populations or are distant from urban centers, so the costs of shipping can be high and there may not be sizable local markets. But most fertile lands are nearer the urban centers, so regional markets might be developed, based on networks of agroecology farms and food hubs that provide an alternative to supermarket supply chains.

Favorable policies

Mier Y Teran Cacho et al. (2018) show that government policies can create new openings for agroecology. While peasant movements have been the major driver in pressing agroecology forward, some government leaders and agencies have been influential allies in weakening policies that entrench industrial agriculture models, and in supporting the growth of niche experiments into larger scale programs. Policy change will be fundamental to any transition in Australia, given its governance system. Many lock-ins are embodied in, and happen through, policies and policy-making instititions.

Governments tend to favor industrial agriculture interests through their policy frameworks, values, and preferences. This is especially the case in Australia: starting in the 1940s, government policies have encouraged productivist agriculture, even as the state retained supply management schemes aimed at sustaining farmer livelihoods. From the 1970s onward, a powerful neoliberal agrarian policy regime has gradually displaced the historical social welfare focus of governments. Instead of nurturing farmers, governments now abandon them to the global economy, with the exception of providing assistance for entering export markets and for exiting the industry. While granting some funds for soil conservation and biodiversity protection, the Abbott/Morrison governments are ignoring the realities of climate change and its impacts. Food industry interests have captured the process of making national food policies; the agricultural scientific, policy-maker, and business communities are captivated by technological solutions.

For agroecology to 'massify' in Australia, there must not only be a movement of farmers toward adopting agroecological practices. There must also be major changes in the priorities and values of government policy-making at all levels. Neoliberal agrarian policy looks 'efficient' but only because it excludes environmental, social, and other impacts, as well as longer-term production declines due to deteriorating climate conditions. Australian governments can:

(1) Start rebuilding a strong social welfare base for farmers and rural/periurban communities that will maintain their livelihoods under conditions of market volatility and climate change.
(2) Take a lead in redefining contemporary agriculture to be place-based and grounded in working with Australian – not European – conditions.
(3) Provide resources to Aboriginal peoples across Australia to exercise their food sovereignty and to rebuild their foodways.
(4) Make agroecology central to research, education, and extension.
(5) Build regional and city food systems that incentiviz eagroecology, and give consumers alternatives to the prevailing supermarket system.
(6) Emphasize meeting food needs for *everyone* within Australia for the long term, before pursuing exports.
(7) Collaborate with communities across Australia to do all of the above, rather than allowing food industry interests to dictate the country's directions.

These are all elements of the People's Food Plan for Australia that the AFSA developed. This transition does not mean foregoing export opportunities. Various government reports, as well as the Australian Council of Learned Academies study of Australia's Agricultural Future, underline the growing demand for safe, green foods in Asia. Yet this demand can only be durably met if agroecological and regenerative practices are widely used, and if farmers can prepare for the future.

Brazil shows how it could be done. Responding to a decade of organizing and policy development by the National Agroecology Alliance and the Brazilian Agroecology Association, the Worker Party governments in Brazil between 2003 and 2016 undertook many activities to strengthen smallholder and family farming (Petersen, Mussoi, and Soglio 2013; Da Costa et al. 2017). These included integrating agroecology into government extension programs and the National Policy for Agroecology and Organic Production (PNAPO), which began in 2012. PNAPO had seven principles, including: "The promotion of food sovereignty, food safety and nutrition and the human right to food through the offer of organic and agroecological products." Between 2012 and 2015, a multi-year implementation plan provided support for 5,300 municipalities to spend at least 30% of their school meal budgets on purchases of organic and agroecological products from family farmers (World Future Council 2019). This plan also supplied funding for agroecology schools, farmer cooperative movements, and extension efforts. While dwarfed by industrial agriculture support, these public resources were much more than had been previously devoted to agroecology. The Fome Zero (Zero Hunger) program also proved highly effective increating a nationwide infrastructure for improving food access for people in poverty (De Schutter 2010). In 2006, a national law was passed to declare a right to food for all citizens.

Of particular interest to Australian state and city governments is the Brazilian city Belo Horizonte's effective food security system. Between 1993 and 2016, this city of 5 million people (comparable to Melbourne and Sydney) was able to cut infant malnutrition and mortality by roughly 50% as well as achieving many other beneficial health outcomes (Chappell 2018). The Municipal Under-Secretariat of Food and Nutritional Security agency oversaw the program. It emphasized real access to food, rather than production and availability of food, through many programs such as popular restaurants and targeted food aid to families. Around 800,000 inhabitants interacted with these programs yearly. One key component was buying vegetables and fruits direct from small farmers in the surrounding rural areas for distribution via schools, restaurants, and other channels. Enabled by city government aid, those farmers could adopt agroecological methods that have improved biodiversity and reduced pesticide use. In Australia, state and city governments could learn from such experiences. State governments used to make agricultural policy – and could do so again, with motivated and visionary leadership that prioritizes agroecology instead of competition and exports. Cities could become new leaders in helping create alternative food systems.

Conclusion

By considering the difficult case of Australia, we can gain insights into what conditions are required for a transition to an agroecological agricultural system. A growing number of niches exist across the county as some farmers experiment with ecological farming methods. A few networks also exist to diffuse agroecological knowledge locally. But they are still small niches in rural areas; they are not yet strongly connected to the Australian food system at multiple scales. The vast majority of farmers and rural communities are still bound within a dominant productivist regime that has proven durable. Numerous socio-ecological and political economy lock-ins constrict the ability of those farmers and communities to experiment with alternative pathways. But by recognizing how these lock-ins work, we can find vulnerable points for disruption and loosening that help create fresh openings for agroecology. Already the landscape level is undergoing major changes: climate change, for one, is intensifying the long-running environmental crisis and changing farmer attitudes. Underpinned by ignorance, the war on land and ecology is looking increasingly futile, even as many farmers persist with destroying their agroecosystems. The regime needs to be exposed for what it is: a system that cannot survive without ever-growing infusions of energy, technology, and chemicals that only lock us deeper into its unsustainable trajectory.

Given the complexity and continental scale of Australian agriculture, multiple transitions around the country – not just one grand transition – are needed.In Australia, agroecological transition will not simply happen through massification

or scaling across that changes the regime. It calls for remaking the cognitive and historical bases of agriculture to begin with. Indigenous peoples, the first peoples who understood how to farm in diverse, often 'inhospitable' conditions, must be at the core of transition. 'Country' must be brought back into agriculture. Transition calls for rethinking of what agriculture is possible, given pre-colonial landscapes and future worlds. Gammage (2011) writes: "We have a continent to learn … we must begin to understand our country. If we succeed, one day we might become Australian."

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